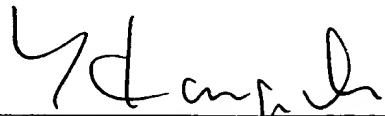


**VERIFICATION OF TRANSLATION**

Japanese Patent Application No. 8-290226  
filed on October 31, 1996

I, Yoshiyuki KAWAGUCHI, a citizen of Japan whose address is c/o SERA, TOYAMA, MATSUKURA & KAWAGUCHI, Yokoyama Bldg., 6th Floor, 4-10, Higashi Nihonbashi 3-chome, Chuo-ku, Tokyo, 103-0004 Japan, am a translator of the document attached and I state that the following is a true translation to the best of my knowledge and belief.

Signature of translator:



KAWAGUCHI, Yoshiyuki, Ph.D.  
Patent Attorney  
SERA, TOYAMA,  
MATSUKURA & KAWAGUCHI

Signed at Tokyo, Japan,  
This 22<sup>nd</sup> day of November, 2005

PATENT OFFICE  
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of  
the following application as filed with this Office.

Date of Application: October 31, 1996

Application Number : 8-290226

Applicant : KYOTO DAIICHI KAGAKU CO., LTD.

Hisamitsu ARAI  
Commissioner,  
Patent Office

Seal

[Name of Document] Application for Patent

[Reference] P-4030

[Date of Filing] October 31, 1996

[Addressee] Commissioner of the Patent Office

[International Classification of Patent]  
G01N 21/78

[Title of Invention] DRY MEASURING DEVICE

[Number of Claims] 5

[Inventor]  
[Address] c/o Kyoto Daiichi Kagaku Co., Ltd.  
57, Nishiaketa-cho, Higashikujo,  
Minami-ku, Kyoto-shi, Kyoto-fu  
[Name] Yoshihiko HIGUCHI

[Inventor]  
[Address] c/o Kyoto Daiichi Kagaku Co., Ltd.  
57, Nishiaketa-cho, Higashikujo,  
Minami-ku, Kyoto-shi, Kyoto-fu  
[Name] Kenji YAMAMOTO

[Applicant]  
[I.D. Number] 000141897  
[Name] Kyoto Daiichi Kagaku Co., Ltd.  
[Representative] Shigeru DOI

[Agent]  
[I.D. Number] 100089244  
[Patent Attorney]  
[Name] Tsutomu TOYAMA

[Appointed Agent]  
[I.D. Number] 100090516  
[Patent Attorney]  
[Name] Hidemi MATSUKURA

[Appointed Agent]

[I.D. Number] 100100549

[Patent Attorney]

[Name] Yoshiyuki KAWAGUCHI

[Telephone Number] 03-3669-6571

[Indication of Official Fee]

[Ledger Number] 012092

[Amount] 21000

[List of Document Submitted]

[Name of Document]

Specification 1 copy

[Name of Document]

Drawings 1 set

[Name of Document]

Abstract 1 copy

[Number of General Power of Attorney]

9504605

[Necessity of Proof] Yes

[Name of Document] Specification

[Title of the Invention] Dry Measuring Device

[Claims]

1. A dry measuring test device, comprising a reagent layer comprising a reagent containing a chromogen and a matrix which retains said reagent in the form of a layer, for determining a substance to be measured in a liquid sample by measuring the degree of coloring of the chromogen generated through the reaction between the substance to be measured and the reagent in terms of reflectance of light entered into the reagent layer, wherein said reagent layer comprises polymer beads embedding light reflective particles.
2. The dry measuring test device as claimed in Claim 1, wherein said light reflective particles are selected from the group consisting of titanium dioxide, zinc oxide, barium sulfate, magnesium oxide, iron (III) oxide and iron (III) hydroxide.
3. The dry measuring test device as claimed in Claim 1, wherein said polymer beads contain as a main component a high molecular compound selected from the group consisting of: polymer or copolymer having as a main component monomers selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, ester of these substances, styrene, and alkylstyrene; polyurethane; polyurea; polyethylene; polypropylene; and polyvinyl chloride.
4. The dry measuring test device as claimed in Claim 1, wherein an average particle diameter of the polymer beads ranges from 1 to 40  $\mu\text{m}$ .
5. The dry measuring test device as claimed in Claim 1, wherein the light reflective particles are contained in an amount of 10 to 70 w/v% based on the total content of the polymer beads, and the polymer beads are contained in an amount of 5 to 80 wt% based on the total weight of the reagent layer.

[Description of the Invention]

[0001]

[Field of Industrial Application]

The present invention relates to a dry measuring test device. More specifically, the present invention relates to a dry measuring test device for determining a substance to be measured in a liquid sample by subjecting the substance to be measured to the coloring reaction and measuring the degree of coloring thus obtained in terms of reflectance, which enables speedy and highly accurate measurement.

[0002]

[Prior Art]

Among the methods for determining a specific component in a liquid sample, in particular, the methods using a dry measuring test device such as test paper have been widely used at present for various purposes because the handling thereof is comparatively easy. Such dry measuring test devices basically have a structure that comprises a reagent layer having a matrix, in which a liquid sample can penetrate and be developed, containing a reagent which is soluble in the above liquid sample and reactive with the substance to be measured to generate a signal such as color, light, or the like, which can be detected and determined by analytical machines.

[0003]

Among the above-described dry measuring test devices, the dry measuring test devices that determine a substance to be measured in a liquid sample through the coloring reaction between the substance to be measured and the reagent usually quantifies the substance to be measured in the liquid sample by measuring an amount of a coloring matter which is colored through the reaction of the substance to be measured with the reagent in terms of reflectance of incident light in the reagent layer. In order to conduct accurate measurement, such dry measuring test

devices based on the coloring reaction contain a reflector in the reagent layer as well as the reagent for coloring. For example, the dry measuring test device described in Japanese Examined Patent Publication No. 7-21455 has a reagent layer containing not only the reagent to be used for the measurement but also, as a reflector, light-reflective water-insoluble particles, for example, white pigments such as titanium oxide, zinc oxide, barium sulfate, magnesium oxide, or the like. When the sample is whole blood, these pigments sometimes play a role of preventing red blood cells which cause measurement errors from invading the reagent layer.

[0004]

However, when the dry measuring device comprises the white pigments as described above as a reflector in the reagent layer, if the white pigments are to be contained in a certain amount to obtain a reflectivity sufficient to enable the measurement, the reagent layer becomes so dense that a liquid sample hardly penetrates it because the particle diameter of the white pigments is extremely small (0.1 to 0.3  $\mu\text{m}$ ). Accordingly, at the time of the measurement, penetration and development of the liquid sample proceeds slowly and it takes long time until the amount of the coloring matter generated by the reaction with the reagent becomes sufficient so as to be measurable. Thus, there is a problem in working performance.

[0005]

Also, in the dry measuring test devices, a concentration condition of the reaction is considerably high, as the reagent is dissolved in the liquid sample to commence the reaction. Further, the matrix which constitutes the reagent layer usually has a structure that it easily becomes dry since its surface area contacting air is large. Although it does not matter very much when measurement is carried out by immersing

the dry measuring test device in a comparatively large amount of the liquid sample, in the case of carrying out the measurement by spotting a small amount of the liquid sample, it is disadvantageous in that the measurement accuracy may possibly reduced by being affected by dryness if the measuring time is prolonged as described above.

[0006]

Therefore, in order to realize speedy and highly accurate measurement using a dry measuring test device that determines a substance to be measured in a liquid sample by subjecting the substance to the coloring reaction and determining the degree of coloring in terms of reflectance, it has been desired to develop a method for obtaining sufficiently measurable reflectance corresponding to a low degree of coloring upon measurement of reflectance, with maintaining such a structure that the liquid sample penetrates the reagent layer of the dry measuring test device to generate a measurable amount of coloring matter within a short period of time, namely, that the measuring time is so short that influence of dryness can be reduced.

[0007]

[Problem to be Solved by the Invention]

The present invention has been made in view of the above point, and therefore it has an object of the invention to provide a dry measuring test device for determining a substance to be measured in a liquid sample by subjecting the substance to the coloring reaction and determining the degree of coloring obtained in terms of reflectance, which enables a short period of the measuring time and gives sufficiently measurable reflectance corresponding to a low degree of coloring upon the measurement of reflectance so as to achieve speedy and high accurate measurement.

[0008]

[Means to Solve the Problem]

As a result of intensive investigation to achieve the above objects, the present inventors found that, in a dry measuring test device for determining a substance to be measured in a liquid sample by subjecting the substance to the coloring reaction and determining the degree of coloring obtained in terms of reflectance, not only rapid penetration of the liquid sample into the reagent layer but also prevention of invasion of red blood cells into the reagent layer can be achieved by providing a reagent layer comprising a reagent containing a chromogen that is reactive with the substance to be measured to develop color and polymer beads embedding light reflective particles as a component of the dry measuring test device.

Thus, the present invention has been completed.

[0009]

According to the present invention, there is provided a dry measuring test device, comprising a reagent layer comprising a reagent containing a chromogen and a matrix having the reagent in the form of a layer, for determining a substance to be measured in a liquid sample by measuring the degree of coloring of the chromogen generated through the reaction between the substance and the reagent in terms of reflectance of light entered into the reagent layer, wherein the reagent layer comprises polymer beads embedding light reflective particles.

[0010]

In the dry measuring test device according to the present invention, the polymer beads which are contained in the reagent layer embeds light reflective particles. Specific examples of the light reflective particles include titanium dioxide, zinc oxide, barium sulfate, magnesium oxide, iron (III) oxide, iron (III) hydroxide, and the like.

[0011]

The polymer beads embedding the above light

reflective particles used in the dry measuring test device of the present invention include those containing as main component a high molecular compound such as: polymer or copolymer having as a main component monomers selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, ester of these substances, styrene, and alkylstyrene; polyurethane; polyurea; polyethylene; polypropylene; and polyvinyl chloride; or the like.

[0012]

In the dry measuring test device according to the present invention, the polymer beads contained in the reagent layer preferably has the size of about 1 to 40  $\mu\text{m}$  in terms of an average particle diameter.

[0013]

Further, in the dry measuring test device according to the present invention, the polymer beads preferably contain the light reflective particles in an amount of about 10 to 70 w/v% based on the total amount of the polymer beads. Such polymer beads are preferably contained in the reagent layer in an amount of about 5 to 80 wt% based on the total weight of the reagent layer.

[0014]

#### [Embodiment of the Invention]

The dry measuring test device of the present invention is described in detail below. First explained are the reagent and the polymer beads embedding the light reflective particles both contained in the reagent layer (the layer in which the matrix contains a reagent-containing composition in the form of a layer) of the dry measuring test device according to the present invention. Subsequently, the reagent layer containing them and the dry measuring test device according to the present invention containing the above reagent layer are explained in this order.

[0015]

(1) Reagent

The reagent contained in the reagent layer of the dry measuring test device according to the present invention comprises a chromogen that can develop color by reacting with the substance to be measured in the liquid sample. Any chromogen may be used as long as the substance to be measured in the liquid sample can be detected by coloring of the chromogen through the reaction between the reagent containing it and the substance to be measured. The term "coloring" used herein means not only color development but also change of color. Further, the "reaction between the substance to be measured and the reagent" includes the case that the substance to be measured itself is a reactant as well as the case that it is involved in the reaction as a catalyst.

[0016]

The reagent containing the above chromogen varies depending on the type of the substance to be measured and is appropriately selected depending on it. This selection is not particularly different from that for the conventional dry measuring test device.

[0017]

For example, the dry measuring test device according to the present invention is preferably used for measuring a substance to be measured in body fluid such as blood, urine, saliva, and the like through the coloring reaction based on the oxidation-reduction reaction. In this occasion, the reagent to be preferably used is the one containing oxidase that oxidizes the substance to be measured, a chromogen, and, if required, peroxidase. In the determination of the substance to be measured by the oxidation reaction using oxidase as mentioned above, coloring matter is generated under the condition that the chromogen to be oxidized is directly oxidized by hydrogen peroxide produced through oxidation of the substance to be

measured by the action of oxidase, or that the chromogen undergoes oxidation coupling by the action of peroxidase, and the thus-produced coloring matter is colorimetrically measured by means of absorptometry or coloration, thereby determining the substance to be measured.

[0018]

Specific examples of the reagent used in the dry measuring test device according to the present invention include a composition containing glucose oxidase, peroxidase, 4-aminoantipyrine, and MAOS (N-ethyl-N-(2-hydroxy-3-sulfopropyl)-3,5-dimethylaniline) or DAOS (N-ethyl-N-(2-hydroxy-3-sulfopropyl)-3,5-dimethoxyaniline) when the substance to be measured is glucose, a composition containing cholesterol oxidase, peroxidase, 4-aminoantipyrine, and MAOS or DAOS when the substance to be measured is cholesterol, a composition containing lactate dehydrogenase, NAD<sup>+</sup>, diaphorase, and tetrazolium violet when the substance to be measured is lactic acid, and p-nitrophenyl-phosphate when the substance to be measured is alkaliphosphatase.

[0019]

The reagent used in the present invention are not limited to those described above, but may be selected depending on the substance to be measured. When the coloring reaction is carried out enzymatically, examples of the enzymes include, in addition to the above-described enzymes, uricase, glycerol-3-phosphate oxidase, choline oxidase, acyl CoA oxidase, sarcosine oxidase, various amino acid oxidases, bilirubin oxidase, lactate oxidase, lactose oxidase, pyruvate oxidase, galactose oxidase, glycerol oxidase, and the like.

[0020]

Examples of the chromogen include a so-called Trinder's reagent (Ann. Clin. Biochem. 6, 24, 1960)

chromogens to be oxidized such as o-anindine, benzidine, o-tridine, or tetramethylbenzidine, and the like.

[0021]

The above-described enzymes can be the substance to be measured as well as the reagent.

[0022]

(2) Polymer beads embedding light reflective particles

The reagent layer of the dry measuring test device according to the present invention comprises polymer beads embedding the light reflective particles in addition to the above-described reagent. The polymer beads function to give sufficiently measurable reflectance corresponding to a low degree of coloring upon the measurement of the degree of coloring obtained in terms of reflectance of reflective light entered into the reagent layer, when the substance to be measured in the liquid sample is reacted with the reagent to develop color. If the liquid sample contains coloring components like whole blood, the polymer beads also function to prevent the coloring components from invading or transmitting the reagent layer and reduce the influence on the reflective light at the reagent layer.

[0023]

As the light reflective particles which are contained in the polymer beads used in the present invention, any particles can be used as long as they have such light reflectivity that gives sufficient reflectance corresponding to a low degree of coloring when it is embedded in the polymer beads for use in the dry measuring test device according to the present invention. Specific examples thereof include white pigments such as titanium dioxide, zinc oxide, barium sulfate, or magnesium oxide, colored pigments such as iron (III) oxide (red) or iron (III) hydroxide (red brown or yellow), and the like. Although the color of these light reflective particles are not particularly

limited as long as they are particles that reflect the light of the wave length used for the measurement, white light reflective particles are preferably used in the present invention.

[0024]

As the polymer beads embedding the above-described light reflective particles, any polymer beads can be used as long as they are polymers that can be made into beads and, by embedding the above-described light reflective particles, can give sufficient reflectance corresponding to a low degree of coloring when it is used in the dry measuring test device according to the present invention. Preferable examples thereof include those containing as a main component a high molecular compound, which are comparatively easily made into the form of beads, such as: polymer or copolymer having as a main component hydrophobic vinyl monomers selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, ester of these substances, styrene, alkylstyrene and the like; polyurethane; polyurea; polyethylene; polypropylene; polyvinyl chloride; or the like.

[0025]

In the dry measuring test device according to the present invention, such polymer beads contain the above light reflective particles in an amount of preferably about 10 to 70 w/v%, more preferably about 20 to 50 w/v%, based on the total amount of the polymer beads. When the substance to be measured in the liquid sample is subjected to the coloring reaction with the reagent and the degree of coloring thus obtained is colorimetrically measured by means of absorptometry, luminescence, or the like, sufficient reflectance corresponding to a low degree of coloring can be obtained by adjusting the content of the polymer beads to about 5 to 80 wt%, more preferably about 10 to 30 wt%, based on the total weight of the reagent layer in

the dry measuring test device according to the present invention.

[0026]

The particle diameter of the polymer beads used in the present invention ranges preferably from about 1 to 40  $\mu\text{m}$ , more preferably about 2 to 30  $\mu\text{m}$ , most preferably about 3 to 15  $\mu\text{m}$ , in terms of an average particle diameter. If the average diameter of the polymer beads is smaller than 1  $\mu\text{m}$ , the reagent layer containing them occasionally becomes so dense that the liquid sample hardly penetrates it and the measurement takes long time because penetration and development of the liquid sample proceed slowly. If the average particle diameter of the polymer beads is larger than 40  $\mu\text{m}$ , they cannot fully prevent coloring components such as blood cells, which interfere the measurement of the degree of coloring, from penetrating the reagent layer.

[0027]

The polymer beads embedding the light reflective particles used in the present invention can be produced by commonly used methods, for example, the method which comprises adding an appropriate amount of the light reflective particles to the raw material for the polymer beads and polymerizing the material thus obtained under the condition that the resulting polymer is made into the form of beads having an appropriate particle diameter. The polymer beads embedding the light reflective particles as described above are also commercially available and, thus, such products can also be used in the present invention. The commercially available polymer beads embedding the light reflective particles are exemplified by Techpolymer manufactured by Sekisui Kaseihin Kogyo Kabushiki Kaisha and the like.

[0028]

(3) Reagent layer

The composition containing the above reagent is retained in the matrix in the form of a layer to constitute the reagent layer. The reagent layer contained in the dry measuring test device according to the present invention contains and stores the above reagent capable of detecting the substance to be measured by developing color through the reaction with the substance to be measured and polymer beads embedding the light reflective particles.

[0029]

The reagent can be contained in the reagent layer in an amount similar to that in the reagent layer of the conventional dry measuring test device. Namely, it can be an amount sufficient and appropriate to the substance to be measured in the liquid sample absorbed in the dry measuring test device at the measurement. The content of the polymer beads embedding the light reflective particles in the reagent layer is as described above.

[0030]

In addition to the reagent and the polymer beads embedding the light reflective particles, the reagent layer of the dry measuring test device according to the present invention can contain, if required, a buffer, a hydrophilic high molecular substance, a surface active agent, a plasticizer, a stabilizer, a pretreating agent, and the like, in an appropriate amount.

[0031]

Examples of the buffer include phosphate buffer, acetate buffer, borate buffer, Tris buffer, Good buffer such as TES (N-Tris(hydroxymethyl)methyl-2-aminoethanesulfonic acid), PIPES (piperidine-1,4-bis(2-ethanesulfonic acid)), and the like. Examples of the hydrophilic high molecular substance include hydroxypropylcellulose, methylcellulose, sodium alginate, polyvinyl alcohol,

polyvinyl pyrrolidone, gelatin, modified gelatin, agar, acrylamide polymer, agarose, and the like. It is possible to add to these hydrophilic high molecular substances an emulsion-type adhesive such as Propiofan (BASF) which is copolymer of vinyl propionate and vinyl acetate, latex particles, or the like. Further, specific examples of the surface active agent include Triton X-100, Triton X-405, Tween-20, Tween-80, Brij-35, and the like. As the pretreatment agent, ascorbate oxidase and the like can be used.

[0032]

As the matrix used to contain and store in the form of a layer the reagent, the polymer beads embedding the light reflective particles, and the above components to be added optionally in the reagent layer of the dry measuring test device according to the present invention, any matrix employed in the commonly used dry measuring test device may be used without any restriction. Examples of the matrix include filter paper, cotton paper, non-woven fabric made of glass fiber or glass fabric, asbestos paper, asbestos fabric, fabric or non-woven fabric made of synthetic fabric such as nylon, polyester, polystyrene, and the like. As described above, though the hydrophilic high molecular substance can be added to the reagent layer, it can also be a material constituting the matrix by itself. Accordingly, when the reagent layer contains the above hydrophilic high molecular substance, the above-described material such as filter paper or the like is not necessarily used. Further, when filter paper and the like material or the hydrophilic high molecular substance alone is used as the matrix, its thickness ranges preferably from about 5 to 100  $\mu\text{m}$ .

[0033]

The reagent, the polymer beads embedding the light reflective particles, and the other components can be contained and retained in the matrix in the form of a

layer by the method commonly used. For example, such methods include the direct immersion method which comprises dissolving or dispersing in a liquid the components to be contained, putting the resulting liquid into a tray, and immersing the matrix in it, the method which comprises coating the liquid containing the above various components on a polymer film such as polyethylene terephthalate (hereinafter referred to as "PET") which is easily separated to give a uniform thickness, placing the matrix thereon to allow it to absorb the liquid followed by drying, and separating the matrix from the polymer film, the method of spraying the liquid containing the above various components on the matrix using a spray or the like, and the method of coating the liquid on the matrix with a bar coater or the like. Drying after immersion can be carried out by the commonly used method. In the reagent layer of the dry measuring test device according to the present invention, the drying temperature ranges preferably from 20 to 60°C.

[0034]

Further, when the matrix is formed by the above hydrophilic high molecular substance alone, it can be carried out by, for example, dissolving or dispersing in a liquid such as water or the like the reagent, the polymer beads embedding the light reflective particles, the hydrophilic high molecular substance, and the other arbitrary components, coating the resulting liquid on a polymer film such as PET or the like to give an appropriate wet thickness, drying it, and separating the matrix from the polymer film. When the reagent layer is formed on the polymer film, the polymer film may be kept if necessary.

[0035]

As described above, the reagent layer containing in one layer the reagent and the polymer beads embedding the light reflective particles can be

obtained. If necessary, the reagent layer may have a two layer structure consisting of the reagent-containing layer and the layer containing the light reflective particle-embedding polymer beads. In this case, each layer can be prepared in accordance with the method for producing the one layer structure as described above. The laminating method may also be carried out by the commonly used method.

[0036]

(4) Dry measuring test device

As described above, the dry measuring test device according to the present invention comprises the reagent layer in which the reagent capable of reacting with the substance to be measured in the liquid sample to develop color, thereby detecting it, the polymer beads embedding the light reflective particles, and various arbitrary components are retained in the matrix in the form of a layer.

[0037]

In the dry measuring test device according to the present invention, while the liquid sample is spotted, penetrates, and develops in the reagent layer, the reagent contained in the reagent layer reacts with the substance to be measured in the liquid sample to generate a coloring matter. Upon colorimetical determination of the degree of coloring thus generated by absorptometry, luminescence, or the like, the polymer beads embedding the light reflective particles in the reagent layer function to give reflectance sufficient for the measurement. When the liquid sample contains the coloring components such as whole blood, the polymer beads prevent the coloring components from penetrating the reagent layer.

[0038]

In addition to the above reagent layer, the dry measuring test device according to the present invention may contain, if necessary, members contained

in the conventional dry measuring test devices, such as a substrate for supporting the reagent layer, a sample retaining layer that retains the liquid sample, a support to secure space to retain the liquid sample, and the like.

[0039]

Examples of the substrates for supporting the above reagent layer include a polymer film as described in the production of the above reagent layer, preferably a polymer film capable of transmitting light but not transmitting liquid, such as PET, polypropylene, or the like. If a substrate is a polymer film transmitting light but not transmitting liquid and is laminated on the reagent layer, it is possible to determine the degree of coloring by irradiating light from the side of the substrate without removing from the surface of the reagent layer the excess liquid sample that has not been absorbed by the reagent layer after the liquid sample is spotted on the surface of the reagent layer.

[0040]

The polymer beads embedding the light reflective particles in the above reagent layer play a role to prevent invasion of the particle components in the liquid sample, such as blood cells, which may enter the reagent layer to reduce sensitivity for measurement of the degree of coloring. If it is possible to measure the degree of coloring from the opposite side of the side where the liquid sample is supplied by using the above substrate, the measurement can be effected more accurately without the influence of the coloring matter such as blood cells since the coloring matter is kept in the supply side.

[0041]

If the coloring reaction between the substance to be measured in the liquid sample and the reagent is accelerated by the permeation of gas such as oxygen, it

is preferable to use as a substrate a porous film which is light-transmissible, liquid-impermeable, and gas-permeable. This is because porosity of the substrate film accelerates the coloring reaction to thereby shorten the reaction time. As to the porous films which are light-transmissible, liquid-impermeable, and gas-permeable, reference can be made to Japanese Examined Patent Publication No. 7-21455 which describes such films in detail. Further, such porous films are commercially available and these can be used in the dry measuring test device according to the present invention. Examples of the commercially available porous films having the above properties include Nuclepore (Nuclepore), Cell Guard (Hoechst Cellanese), Cyclopore (Whatman), and the like.

[0042]

As the sample retaining layer for retaining the above liquid sample, those having the same construction as the sample retaining layer (which may generally be called the "diffusion layer" or the "developing layer") used in the conventional dry measuring test device can be used.

[0043]

In the dry measuring test device according to the present invention, it is possible to make space for retaining the liquid sample instead of placing the above sample retaining layer. For this purpose, a support may also be used. The dry measuring test device having the above-mentioned support is exemplified by the one that is constituted by the reagent layer on which the above-described substrate may be laminated and the support for making space to retain the liquid sample, as Fig. 1 shows its sectional view.

[0044]

In Fig. 1, a support 1 has in its inside a capillary compartment 2 for retaining the liquid sample

and three holes which connects the capillary compartment with the outside of the support, namely, a light irradiation hole 3 for measuring the degree of coloring, a liquid sample-injecting hole 4, and an air hole 5. A reagent layer 6 is placed in the capillary compartment of the support so as to cover the light irradiation hole 3. If the substrate is laminated on the reagent layer, it is placed so that the measuring light can be irradiated from the side of the substrate. The support in such a dry measuring test device can be constituted by a polymer which is liquid impermeable and does not dissolve in the liquid sample. In the present invention, it is preferable to give the support light blocking property by, for example, blackening the support. The support having light blocking property can make it possible to reduce the influences of absorbance and scattering of the measuring light by a solid matter in the liquid sample, and external stray light entered from the outside of the support.

[0045]

Although the dry measuring test device according to the present invention can be used for any method for measuring the substance in the liquid sample, which can generate a coloring matter through the reaction with various reagent, it can be preferably applied to the measurement of the substance contained in body fluids such as blood, urine, saliva, or the like is to be measured through the coloring reaction utilizing oxidation-reduction reaction, for example, the measurement of the content of glucose in blood using the reagent as described in detail above.

[0046]

[Example]

An example of the present invention is demonstrated below.

[0047]

<Preparation of dry measuring test device>

Each component was mixed to give a composition as shown in Table 1 to prepare the coating liquid for the reagent layer. Cell Guard (Hoechst Cellanese) used for the matrix of the reagent layer was attached on a glass plate so as to form no wrinkle. The above coating liquid was coated on the resulting Cell Guard using a knife coater to give a thickness of 50  $\mu\text{m}$  and dried at 25°C and at a humidity of 15% for 30 minutes to form the reagent layer. Then, the reagent layer with Cell Guard was peeled from the glass plate and cut into the size of 7 mm x 7 mm.

[0048]

The resulting reagent layer with Cell Guard having a size of 7 mm square was attached on a PET film having a size of 30 mm x 7 mm with a hole of 4 mm $\phi$  (a measuring light irradiation hole) so that the side of Cell Guard could face the PET film to cover the hole. A cover was attached on the reagent layer side of the PET film with a thermoplastic resin so as to form the capillary compartment between the cover and the PET film. Therefore, an example of the dry measuring test device was prepared. The cover used herein had the liquid sample-supplying hole and the air hole (cf. Fig. 1).

[0049]

For comparison, a dry measuring test device was prepared in the same manner as in the above Example except for using the light reflective particles (titanium dioxide) which were contained in the polymer beads (Techpolymer MBX-5/White) in place of the light reflective particle-embedding polymer beads used in the coating liquid for the reagent layer.

[0050]

[Table 1]

Table 1

Component	Amount	
	Example	Comparative example
Borate buffer (150 mM, pH 7.0)	29.0 g	29.0 g
Hydroxypropyl cellulose	1.3 g	1.3 g
Techpolymer MBX-5/White	5.0 g	-
Titanium dioxide	-	2.7 g
Propiofan (BASF)	1.3 g	1.3 g
TES buffer (300 mM, pH 7.0)	5.0 g	5.0 g
Tween-20 (50 wt%)	3.2 g	3.2 g
Glucose oxidase	138 ku	138 ku
Peroxidase	103 ku	103 ku
4-Aminoantipyrine	0.2 g	0.2 g
MAOS (Dojin)	0.5 g	0.5 g
Distilled water	2.4 g	4.6 g

[0051]

In Table 1 above, Techpolymer MBX-5/White (Sekisui Kaseihin Kogyo) is polymer beads of true sphere crosslinked polymethylmethacrylate having an average particle size of 5  $\mu\text{m}$  in which each bead contains titanium dioxide in an amount of 50 w/v%.

[0052]

<Evaluation of dry measuring test device according to the present invention>

The dry measuring test devices obtained in the above Example and Comparative example were tested for permeability and the reaction rate.

[0053]

#### (1) Permeability test

After whole blood was allowed to stand at room temperature for one day for glycolysis, food colorant blue No. 1 was added thereto in an arbitrary amount and the hematocrit value was adjusted to 68%. Thus, sample I was obtained. 10  $\mu\text{l}$  of sample I was introduced into the reagent layer of the dry measuring test device obtained in the above Example through the liquid sample-supplying hole. From 5 seconds later, light of

640 nm was irradiated from the side of Cell Guard through the measuring light-irradiation hole and obtained reflectance was measured using a reflectiometer (color-difference meter) in the passage of time at 10-second intervals for 125 seconds. The same test was carried out for the dry measuring test device obtained in the Comparative Example. Fig. 2 shows the results of time-course change of reflectance measured for sample I using the dry measuring test devices obtained in the Example and Comparative Example. In Fig. 2, the axis of ordinate and the axis of abscissa stand for reflectance (%) and the measuring time (sec), respectively.

[0054]

(2) Reaction rate test

Whole blood (glucose concentration: 99 mg/dl) supplemented with a glycolysis inhibitor (NaF) was adjusted to have a hematocrit value of 68% to serve as sample II. 10  $\mu$ l of sample II was introduced into the reagent layer of the dry measuring test device obtained in the above Example through the liquid sample-supplying hole. From 5 seconds later, light of 640 nm was irradiated from the side of Cell Guard through the measuring light-irradiation hole and obtained reflectance was measured using a reflectiometer (color-difference meter) at 10-second intervals for 125 seconds. The same test was carried out for the dry measuring test device obtained in the Comparative Example. Fig. 3 shows the results of time-course change of reflectance measured for sample II using the dry measuring test devices obtained in the Example and Comparative Example. In Fig. 3, the axis of ordinate and the axis of abscissa stand for reflectance (%) and the measuring time (sec), respectively.

[0055]

As apparent from these results, the sample liquid

permeated the reagent layer well and, actually, the reaction rate of the reaction between the reagent and the substance to be measured was high in the dry measuring test device obtained in the Example as compared with the conventional dry measuring test device containing titanium dioxide as a reflective member.

[0056]

[Effect of the Invention]

If the dry measuring test device according to the present invention is used for the measurement of the substance to be measured in the liquid sample by subjecting the substance to the coloring reaction and determining the degree of coloring in terms of reflectance, it is possible to shorten the measuring time and to obtain sufficiently measurable reflectance corresponding to the low degree of coloring upon the measurement of reflectance. Therefore, quick and highly accurate measurement is enabled.

[Brief Explanation of the Drawings]

[Fig. 1] It is a sectional view showing an example of the dry measuring test device according to the present invention.

[Fig. 2] It shows a time-course change of reflectance measured at 640 nm of a specimen, which was prepared by subjecting whole blood to glycolysis and adding thereto food color blue No. 1, using the dry measuring test devices obtained in the Example and Comparative Example.

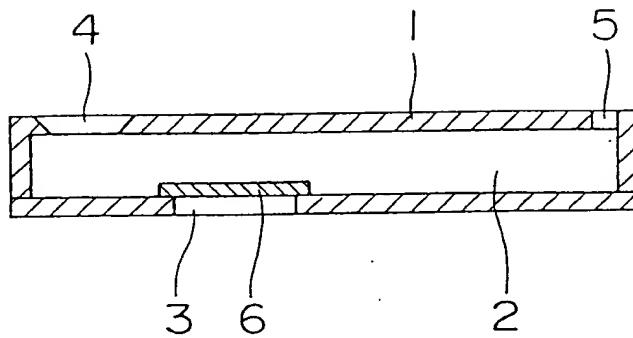
[Fig. 3] It shows the time-course change of reflectance measured at 640 nm of a whole blood specimen using the dry measuring test devices obtained in the Example and Comparative Example.

[Explanation of symbol]

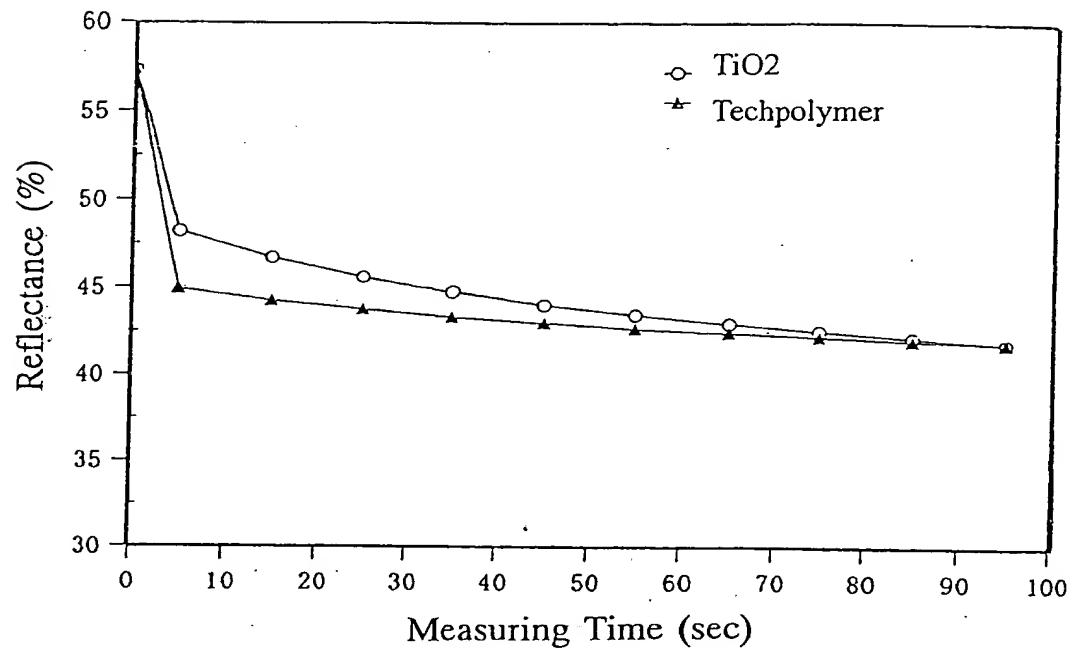
- 1 support
- 2 capillary compartment
- 3 light irradiation hole
- 4 liquid sample-injecting hole

5 air hole

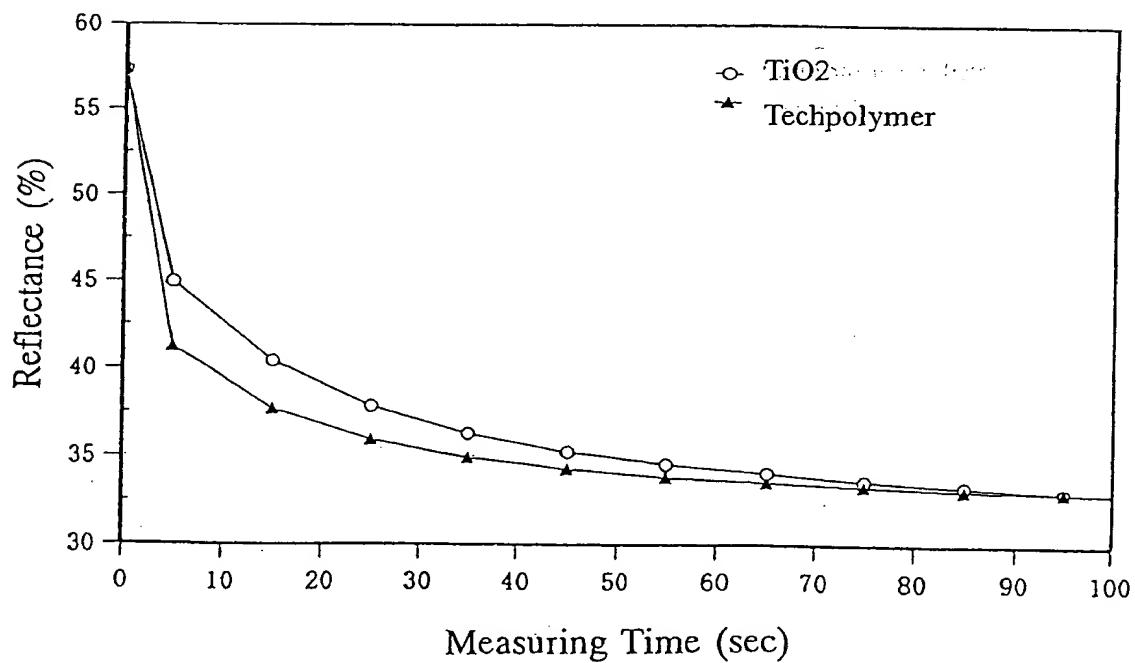
[Document Name] Drawings  
[Fig. 1]



[Fig. 2]



[Fig. 3]



[Name of Document] Abstract

[Abstract]

[Object] It is to provide a dry measuring test device for determining a substance to be measured in a liquid sample by subjecting the substance to the coloring reaction and determining the degree of coloring obtained in terms of reflectance, which enables a short period of the measuring time and gives sufficiently measurable reflectance corresponding to a low degree of coloring upon the measurement of reflectance so as to achieve speedy and high accurate measurement.

[Solving Means] In a dry measuring test device, comprising a reagent layer comprising a reagent containing a chromogen and a matrix which retains the reagent in the form of a layer, for determining a substance to be measured in a liquid sample by measuring the degree of coloring of the chromogen generated through the reaction between the substance to be measured and the reagent in terms of reflectance of light entered into the reagent layer, the reagent layer is caused to comprise polymer beads embedding light reflective particles.

[Drawing selected] Figure 2